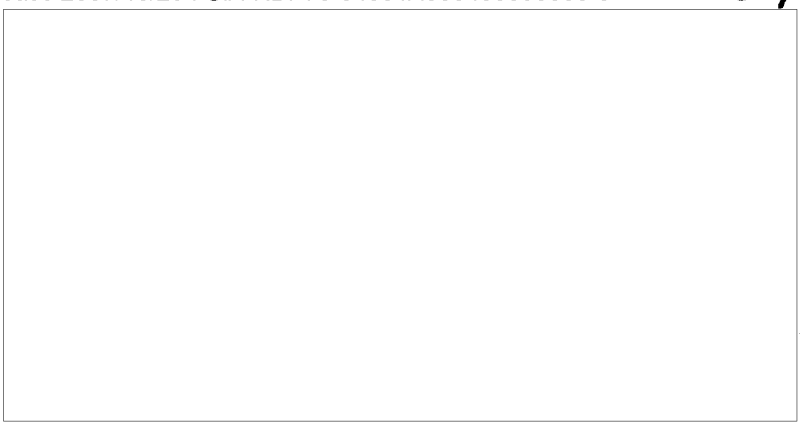
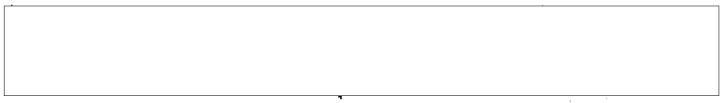


SOLID SOLUTION IN A^{III} B^{V} COMPOUNDS

O. G. Folberth

Zeitschrift für Naturforschung, 10a (1955) 502-503
(From German)

25X1



September 1955

SOLID SOLUTION IN A^{III} B^{V} COMPOUNDS

O. G. Folberth

Zeitschrift für Naturforschung, 10a (1955) 502-503
(From German)

Germanium and silicon form a complete solid solution series. It is therefore possible to produce a Ge-Si alloy of any desired value of the forbidden band ΔE between that of pure Ge (0.69 eV) and that of pure Si (1.03 eV) [1]*.

The A^{III} B^{V} compounds supplement the elements Ge and Si with semi-conductors of similar properties in which the forbidden bands, generally speaking, lie below that of Ge and above that of Si [2]. The object of the present research was to determine whether the range of possible ΔE values could be further extended by solid solution between A^{III} B^{V} compounds.

Previous known investigations have met with no success. Köster and Thoma [3] investigated the quasi-binary phase diagrams InSb-GaSb, InSb-AlSb and GaSb-AlSb. In all three cases degenerate eutectic diagrams were obtained without any ascertainable mutual solubility of the compounds.

Shi and Peretti [4] investigated the system InSb-InAs. In this case also a degenerate eutectic diagram was obtained. There was no solubility of InSb in InAs and at the most only 2% of InAs in InSb.

These results are to some extent surprising since for example GaSb and AlSb possess very similar lattice constants (6.08 Å and 6.09 Å respectively). In what follows we give our own results concerning solid solution in A^{III} B^{V} compounds for the systems InAs-InP and GaAs-GaP. Solid solution occurred in these systems although the lattice constants of the boundary compounds did not show nearly such good agreement as the GaSb-AlSb system used by Köster and Thoma.

THE InAs-InP SYSTEM

Three samples with the approximate compositions InAs:InP 3:1, 1:1 and 1:3 were first investigated**. Debye-Scherrer diagrams showed lines of the ZnS type from which the lattice constants of the solid solutions were calculated as:-

InAs	α = 6.04 Å
$In(As_{0.75}P_{0.25})$	5.99 Å
$In(As_{0.5}P_{0.5})$	5.93 Å
$In(As_{0.25}P_{0.75})$	5.89 Å
InP	5.86 Å

---

* For references, see end.

** The composition of all samples is only accurate to a few per cent. In particular the samples might have contained rather more P than indicated. The results of this work must therefore be regarded as a preliminary communication.

These figures indicate a constant variation of the lattice constants with composition as is usual with solid solutions. The quasi-binary phase diagram InAs-InP indicates the possibility of solid solution in all concentrations. Investigation is made difficult by the relatively high vapour pressure (especially in phosphor rich alloys). Further investigations were restricted to alloys containing up to 20% InP. The variation of the forbidden band ΔE and the electron mobility μ_n with composition are of special interest (Figure 1). The mobility μ_n was calculated from the specific conductivity σ and the Hall coefficient R, $\mu_n = 8/3\pi \cdot R\sigma$. The ΔE values were obtained from the location of the optical absorption edge [5]. By way of comparison Figure 2 shows a number of curves of R as a function of $1/T_{abs}$ for InAs and $In(As_{0.85}P_{0.15})$. It will be seen that for $In(As_{0.85}P_{0.15})$ the intrisic conduction zone is displaced towards higher temperatures compared with InAs.

THE GaAs-GaP SYSTEM

GaAs-GaP also forms a complete solid solution series. Our investigations were at first restricted to solutions containing more than 50% GaP. The solutions are transparent and thus the variation of ΔE with composition is clearly visible. For $Ga(As_yP_{1-y})$ with $0 < y < 0.1$ the colour of the solution is orange and is scarcely distinguishable from pure GaP (ΔE = 2.24 eV) [6]. For $0.1 < y < 0.3$ the colour is reddish, for $y \approx 0.4$ red, for $y \approx 0.5$ dark red and for $y > 0.6$ the solution is opaque. Figure 1 shows ΔE calculated from the location of the optical absorption edge in relation to the concentration.

SUMMARY

The quasi-binary systems InAs-InP and GaAs-GaP form complete solid solution series. Thus it is possible to form $A^{III}B^{V}$ compounds of any value of ΔE between 0.33 and 1.25 eV and between 1.45 and 2.25 eV (shaded sections of the ΔE scale in Figure 1).

REFERENCES

[1] A. LEVITAS, C.C. WANG and B.H. ALEXANDER. Phys. Rev., 95 (1954) 846.

[2] H. WELKER. Physica, 20 (1954) 893.

[3] W. KÖSTER and B. THOMA. Z. Metallkunde 46 (1955) 293.

[4] L. SHI and E.A. PERETTI. J. Amer. Chem. Soc. 75 (1953) 608.

[5] F. OSWALD and R. SCHADE. Z. Naturforschg. 9a (1954) 611.

[6] O.G. FOLBERTH and F. OSWALD. Z. Naturforschg. 9a (1954) 1050.

E.L.

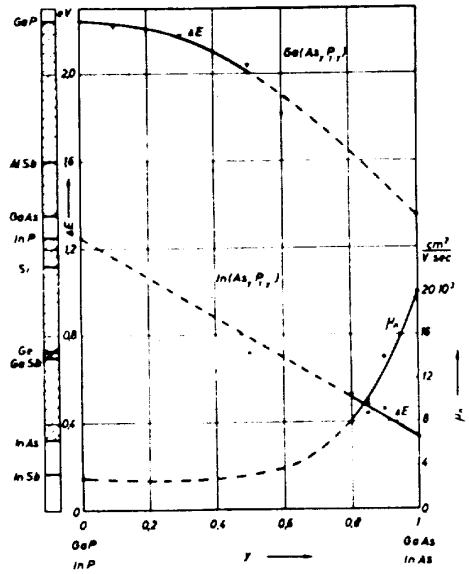


Fig.1: Forbidden bands of the solid solution $In(As_yP_{1-y})$ and the solid solution $Ga(As_yP_{1-y})$ also the electron mobility μ_n of the solid solution $In(As_yP_{1-y})$ in relation to the composition y (Values at room temperature).

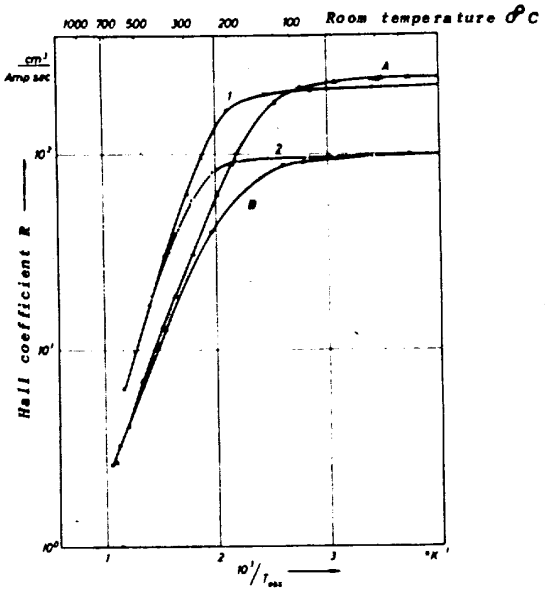


Fig. 2: Hall constant R as a function of $1/T_{abs}$ for $In(As_{0.85}P_{0.15})$ [samples 1 and 2] and for InAs [samples A and B].